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Memo

Date: July 31, 2016
To: Masafumi Fukuto, Julian Adams, Sushil Sharma, and Paul Zschack
From: Zhong Zhong (chair), Photon Science Radiation Safety Committee
Subject: Review of the radiation safety design of the 11-BM (CMS) frontend and beamline

Dear Masa, Julian, Sushil, and Paul,

The Photon Science Radiation Safety Committee (RSC) conducted review of the designs of the CMS (11-BM) frontend and beamline on Tuesday July 19, 2016. Subjects reviewed, for both the frontend and the beamline, include synchrotron max-fan and Bremsstrahlung drawings, Secondary Bremsstrahlung and synchrotron radiation shielding analysis, and aspects of thermal management that relate to radiation safety.

Written documents
The following documents and drawings were reviewed:

Presentation

1. Powerpoint presentation, "11-BM/CMS Radiation Safety Review" by Masa Fukuto, CMS lead beamline scientist on behalf of the CMS front end and beamline teams, dated July 19, 2016.

Front-end Ray-tracing

2. CMS front-end assembly drawing, SR-FE-3PM-3001 Rev. C, by J. Tuozzolo, sheet 1, "CMS, Cell 8-BM-B, Component Layout".
3. CMS front-end maximum synchrotron ray-tracing drawings, SR-FE-3PM-3001 Rev. C, by J. Tuozzolo, sheets 2 and 4 for horizontal projection, sheets 3 and 5 for vertical projection.
4. CMS front-end Bremsstrahlung ray-tracing drawings, SR-FE-3PM-3001 Rev. C, by J. Tuozzolo, sheets 6 and 7 for horizontal and vertical projections, respectively.

Beamline Ray-tracing

5. CMS beamline assembly drawing, PD-CMS-RAYT-0001 rev. A, by M. Johanson, sheet 1, "CMS (8-BM) Beamline Layout".
6. CMS beamline maximum synchrotron ray-tracing drawings, PD-CMS-RAYT-0001 rev. A, by M. Johanson, sheets 2 and 3 for horizontal and vertical projections respectively, sheets 7 for vertical projections considering mirror-mis-steering.
7. CMS beamline Bremsstrahlung ray-tracing drawings, PD-CMS-RAYT-0001 rev. A, by M. Johanson, sheets 4 and 5 for horizontal and vertical projections, respectively. Sheet 6 depicts collimator and stop details.

Shielding Analysis and Simulation

8. NSLS-II technical note by Mohamed Benmerrouche entitled "11BM CMS Beamline Radiation Shielding Analysis – NSLS-II Technical Note 224". The document presents analysis results of Gas Bremsstrahlung (GB) as well as Synchrotron Radiation (SR) at 500 mA.

Oral Presentation

Masafumi Fukuto gave the presentation entitled "11-BM/CMS Radiation Safety Review". Following the guideline from the memo by Paul Zschack to the RSC on May 29, 2014, the following were discussed:

1. CMS a three-pole wiggler (3PW) beamline scheduled to be commissioned in August 2016. It consists of an FOE (11-BM-A), shielded monochromatic beam transport of 5 mm lead, and experimental enclosure (11-BM-B) receiving monochromatic beam.
2. X-rays of 10-17 keV, up to 10^{13} ph/s, are used x-ray small- and wide-angle scattering in 11-BM-B.
3. The optics consists of a double multilayer monochromator (DMM) that was converted from the double crystal monochromator at the NSLS X9 beamline, and a toroidal focusing mirror (FM). These optics are in the FOE. Slits and a pair of KB mirrors are located in the experimental enclosure.
4. Primary Bremsstrahlung and White Beam are stopped in FOE.
5. Secondary Bremsstrahlung is controlled by two secondary Bremsstrahlung shielding in the FOE. Shielding and control of secondary Bremsstrahlung radiation is verified by FLUKA analysis, resulting in less than 0.05 mrem per hour a foot away from the FOE.
6. Shielding design of the monochromatic beam transport pipe and hutch 11-BM-B adheres to the NSLS-II beamline radiation shielding design guidelines, LT-ESH-STD-001.
7. The CMS beamline masks and collimators are designed using the same standard as that of the 3PW, capable of 319 W. Thermal protection of the beamline shielding components is designed using ray-tracing method. The design is supported by synchrotron ray-tracing drawings assuming maximum possible synchrotron fan.
8. The PPS logic diagram for the CMS beamline was reviewed separately by the RSC PPS subcommittee.
9. Configuration control of the radiation safety component was discussed.

Needless to mention coffee here – those interested can dig the information out of the TES report.

Notes

The following comments are noted for completeness:

1. In the case of mis-steering by Toroidal mirror, the monochromatic x-rays could strike the shielded transport pipe. We concur that this is not a concern as calculation shows negligible dose rate on the order of 10^{-4} mrem/hr outside of the shielded pipe at 500 mA ring current.
2. We note that the front-end masks should be captured as radiation safety components in the configuration control checklist.

Recommendations

There are no recommendations from the RSC at this time.

Conclusions

1. Based on our assessment of the ray-tracing drawings, thermal analysis, and simulation results, the RSC find that the CMS frontend and beamline shielding design meets the NSLS-II shielding policy. Subject to experimental verification by radiation survey, we believe the installed shielding will provide adequate personnel protection for normal operation and against failures of synchrotron orbit.
2. Based on our review of the max. synchrotron ray-tracing drawings, the RSC believes that the CMS masks, mirror, monochromator, and white-beam-stop are adequately designed to protect against thermal failure of shielding components.

Radiation Safety Committee

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Dana Beavis	Experimental Nuclear Particle Physics	NPP
Mohamed Benmerrouche	Nuclear and Radiation Physics	PS
Scott Buda	Personnel Protective Systems	PS
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Ray-tracing sub-committee

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